

# Report on Rapid Transit for San Francisco

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Consulting Engineers of New York City

To the Honorable  
Public Utilities Commission of the  
City and County of San Francisco  
Gentlemen:

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## SAN FRANCISCO RAPID TRANSIT

Based on our survey of the existing transportation facilities, an examination of the rapid transit plans prepared under the direction of Mr. Paul J. Ost, Chief Electrical Engineer of the Public Utilities Commission, and our study of the rapid transit requirements of the City of San Francisco, we recommend the construction of the following routes, totalling  $8\frac{1}{2}$  miles, as an "Initial Rapid Transit Subway System" for the City of San Francisco:

1. **Market Street Route:**—Beginning near Howard Street, under Fremont Street, and extending northerly to Market Street, thence westerly under Market Street to Church Street where a ramp to the surface is to provide track connections to the existing Twin Peaks and Sunset Tunnels and to the Church Street surface car line. This route consists of  $2\frac{1}{2}$  miles of two-track subway.

2. **A Mission Street-Bernal Cut Route:**—Beginning as a subway at a junction with the Market Street Route near Van Ness Avenue, and extending southerly under Mission Street to 24th Street, thence under the old right of way of the Southern Pacific Co. to a ramp reaching the surface near Dolores Street and 27th Street, thence westerly and southerly along the surface of the Southern Pacific Co. right of way and the Bernal Cut to Monterey Boulevard. This route, totalling  $3\frac{1}{2}$  route miles, consists of two miles of two-track subway and  $1\frac{1}{2}$  miles of two-track surface line.

3. **A Geary Street-Montgomery Street Route:**—Beginning at a ramp in Geary Street opposite Hamilton Square and extending east under Geary Street to Market Street, thence easterly under Market Street to Montgomery Street, thence north under Montgomery Street to a ramp on Columbus Avenue near Washington Street. Suitable track connections from the subway to the existing surface lines of the Municipal Railway System are to be made at both ramps of this route. This route consists of  $2\frac{1}{2}$  miles of two-track subway.

4. **Connecting Bus Lines:**—In the residential sections a sufficient number of bus lines are to be operated to supplement the service of the rapid transit routes. These buses will provide convenient access to the rapid transit lines, thereby extending the benefits of the latter to larger territories.

Accompanying this report are two maps of the City of San Francisco, one shows the proposed rapid transit routes and the other the subways and connecting street railway surface routes, with the areas marked which will be within five minutes walking time of the proposed rapid transit service.

## ESTIMATED COST OF THE RAPID TRANSIT SYSTEM

The cost of construction of the rapid transit system was estimated by the City Engineer, and that for equipment by the Engineers of the Public Utilities Commission. These estimates were analyzed, and in our opinion represent the cost of the work under present conditions. In analyzing the estimate, consideration was given to the uncertainty in the trend of material prices and wage rates. The cost of right of way to be acquired was accepted as estimated because this item of cost is subject to the approval of the Real Estate Department. The estimated cost of the Initial Rapid Transit Subway System is:—

1. Market Street Route .....	\$17,900,000
2. Mission Street-Bernal Cut Route.....	14,200,000
3. Geary Street-Montgomery Street Route.....	13,600,000
4. Right of Way to be Acquired.....	1,000,000
5. Interest during Construction.....	6,000,000
TOTAL .....	\$52,700,000

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The above recommended "Initial Rapid Transit Subway System" is the result of a careful survey of the City and its present local transportation facilities. Records and reports were studied to determine the present and future local transportation requirements. The conditions created by the construction of the Transbay Bridge were taken into consideration. The routes recommended for construction are, in our opinion, adequate for the immediate needs of the City and are planned so that they can be extended later to form part of a comprehensive system which will provide adequate transportation facilities for the Greater San Francisco of the future.

The construction of the subway system will provide work for thousands of mechanics and laborers for several years, as subway construction requires a larger proportion of local labor than any similar municipal improvement except highways, sewers or park developments. This employment will create increased purchasing power for a considerable portion of the population, thereby improving business conditions. It will also stimulate the building industry by inducing new commercial and residential construction and the modernization of existing properties.

## NEED FOR RAPID TRANSIT IN LARGE CITIES

In connection with the investigation of the transportation facilities of the City of Chicago some years ago, it was stated that "The greatest difficulty in developing a transportation system for a modern city is that it can never be completed, but that it is always growing; in fact, the traffic increases at a faster rate than the population of a city. If the population of a city is doubled, there are not only twice as many people to carry, but the number of rides per capita is increased and the distances that must be travelled grow longer. A satisfactory transportation plan must be based on a definite and sound theory and at the same time it must be sufficiently elastic to meet the varying conditions that arise from time to time".

The transportation system of a modern city has been likened to the arteries of a human being. If the arteries function properly the body thrives, but if they become deranged the patient sickens or dies. So with a city, if the transportation system does not adequately serve the community, the city ceases to grow and the people will go elsewhere to live or work.

In large cities where residential areas are no longer accessible from the business district in a reasonable travel time, they must be brought nearer to the center of the community by means of rapid transit. This will prevent congestion of population, promote modern standards of living in healthful surroundings, and aid in the development of a logical city plan. In the business district and in the surrounding congested areas, rapid transit can only be provided by removing the transportation facilities from the street surface by the construction of elevated railways or subways.

## ELEVATED RAILWAYS

Elevated railways have the advantage of lower first cost, as they can be built at about one-third the expense necessary to construct subways of equal length and capacity. Furthermore, being in the open air, many riders prefer them to subways as a transportation medium.

Elevated railways, however, interfere with the light, air and access of abutting property, making it less desirable for business and residential purposes, thus depreciating its value. The noise resulting from overhead train operation is objectionable to those living or working along the line. Vehicular traffic avoids streets encumbered with elevated structures, thus increasing congestion on nearby parallel thoroughfares.

Experience in New York City has shown that elevated railways have, since their construction, retarded the development of real estate along the streets where they were built. In the same neighborhood, properties along streets which were not encumbered by elevated railways have been improved with modern buildings, while properties along streets over which they are located have remained stationary or have deteriorated. That this condition was caused by the presence of the elevated railway is proven by the fact that the removal of short lengths of elevated railways in New York City has resulted in the construction of high class modern buildings and in the modernization of the remaining older buildings along

these streets. As a result of these experiences the City of New York has officially banned the construction of further elevated railways.

## SUBWAYS

While the cost of constructing subways is greater than the cost of building elevated railways, their selection for rapid transit lines is warranted because they enhance the value of abutting property as well as property in the vicinity of the subway route, particularly in cross streets at stations. The streets traversed by subways are benefited by the elimination of noise inherent in the operation of surface cars or elevated railways. The community is benefited by the reduction in traffic congestion at the street surface, and by greater tax returns due to the increased value of real estate. Experience in other cities shows that subways attract business and population to the areas for which they provide rapid transit facilities.

Even though subways cannot be financially self-supporting at a reasonable rate of fare, they should be built as a civic necessity in a manner similar to schools, hospitals, governmental buildings and water supply systems, some of which are only in part income producing.

## REASON FOR RAPID TRANSIT FOR SAN FRANCISCO



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## REFERENCE BOOK

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San Francisco at the head of a peninsula, 46 square miles comprising the City, which is more densely populated than any other American cities, a street layout antedating the automobile, and a constantly increasing population of 800,000 people, to which are added about 100,000 people, create a congestion in the City, and the use of the surface cars to such an extent that it takes longer distances faster by walking than by car. The time and energy wasted by the car is a serious economic loss to the community under the present day conditions, and the prospective benefits have been ably described in previous reports. It has been shown the necessity for rapid transit. It is recommended that transit routes and of the type of system be selected for community benefit at the lowest cost.

It is essential that the people be able to reach their destinations in less time than is possible from the present system. The rapid transit system recommended is of the purpose.

It is not as yet warrant such extensive systems as have been built in London, New York, and Chicago, in which multiple unit trains are used in place of the surface transportation facilities. The City can best be served by subways in which the surface cars are operated until such time as the need for the subway transportation system arises.

It is recommended that the subways recommended are to be so designed that a change from street car to train operation can readily be made.

## UNIFICATION OF THE TRANSPORTATION SYSTEMS

Should unification of the City's surface car transportation systems be consummated, the subways recommended in this report will serve as the trunk lines for the unified system. Unification of the City's transportation facilities is desirable as it would provide a more flexible service and increase the efficiency of the entire transportation system. It would make for economies in management and operation by eliminating overlapping services, so that more and better service could be rendered without increasing the cost of operation. Services controlled by different managements cannot be operated advantageously over the same rapid transit tracks. Consequently unification would permit the routing of additional surface car lines over the recommended rapid transit system.

## MIXED OPERATION

The possibility of operating interurban trains over the tracks of the rapid transit system has been suggested. The space requirements for and operating characteristics of interurban trains are different from those of





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Even though subways cannot be financially self-supporting at a reasonable rate of fare, they should be built as a civic necessity in a manner similar to schools, hospitals, governmental buildings and water supply systems, some of which are only in part income producing.

## **NEED FOR RAPID TRANSIT FOR SAN FRANCISCO**

The unique location of San Francisco at the head of a peninsula, the peculiar topography of the 44 square miles comprising the City, which differs from that of most other American cities, a street layout antedating the era of tall buildings and automobiles, and a constantly increasing population at present totalling about 700,000 people, to which are added about 75,000 non-residents daily entering the City, create a congestion in the business district which slows down the surface cars to such an extent that it is often possible to traverse distances faster by walking than by riding. While not readily apparent, the time and energy wasted because of street congestion represent a serious economic loss to the community. The past growth, the present day conditions, and the prospective development of San Francisco have been ably described in previous reports. These reports have already shown the necessity for rapid transit. The determination of suitable rapid transit routes and of the type of structure to provide the maximum community benefit at the lowest cost is the next essential step.

In order that San Francisco may continue to maintain its position as a commercial and financial center, it is essential that the people be provided with local transportation facilities which will enable them to reach the business district from their homes in less time than is possible from communities beyond the City limits. The rapid transit system recommended herein will accomplish that purpose.

Conditions in San Francisco do not as yet warrant such extensive and costly subway transportation systems as have been built in London, Paris, New York and Philadelphia, in which multiple unit trains are operated, entirely separated from the surface transportation facilities. The present transportation needs of the City can best be served by subways in which cars of connecting surface lines are operated until such time as the growth of population and the extension of the subway transportation system make it necessary to provide multiple unit trains. The subways recommended are to be so designed that a change from street car to train operation can readily be made.

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Should unification of the City's surface car transportation systems be consummated, the subways recommended in this report will serve as the trunk lines for the unified system. Unification of the City's transportation facilities is desirable as it would provide a more flexible service and increase the efficiency of the entire transportation system. It would make for economies in management and operation by eliminating overlapping services, so that more and better service could be rendered without increasing the cost of operation. Services controlled by different managements cannot be operated advantageously over the same rapid transit tracks. Consequently unification would permit the routing of additional surface car lines over the recommended rapid transit system.

## **MIXED OPERATION**

The possibility of operating interurban trains over the tracks of the rapid transit system has been suggested. The space requirements for and operating characteristics of interurban trains are different from those of

the surface cars to be operated in the subway. It is our opinion that the operation of these two different and diverse services over the same tracks is not practicable under conditions existing in San Francisco.

## DISCUSSION OF THE PROPOSED SUBWAY ROUTES

**Market Street Route**—A two-track subway is to be built for present requirements along Market Street, designed so that two more tracks can be added in the future when a four-track subway is required under this street.

Market Street being the most important business thoroughfare of San Francisco, may be called its axial street and into it converge many of the street car lines of the City. The downtown destination of most of the car riders however, is the territory lying north of Market Street. If a parallel street to the north were available, it would be the ideal location for a rapid transit line. The nearest available thoroughfare to the ideal transportation line is Market Street, it was therefore selected for the main subway route, and in our opinion it should be so used rather than any parallel street to the south. Furthermore, to put the rapid transit line elsewhere than Market Street, would upset the natural development of more than three-quarters of a century and seriously injure many well established businesses. If Mission Street was used for the subway instead of Market Street, it would involve an additional walk of 600 feet twice a day for most of the subway passengers, requiring time which would offset some of the advantages gained by rapid transit. Subway transportation is a commodity placed at the disposal of the public at a high cost and it can only be sold in satisfactory volume if it is offered at the locations where the public wants it.

It is desirable to provide a subway station of the Market Street Route at the railway terminal of the Transbay Bridge wherever that terminal may be located. On the assumption that it will be placed at the location known as "Plan X" it is proposed to turn the Market Street Subway tracks south under Fremont Street with a subway station located for convenient transfer of passengers to the elevated Transbay Bridge Terminal Station. This will make it possible, in the future, to extend the rapid transit tracks from the Fremont Street Subway station to the Southern Pacific Company passenger station at Third and Townsend Streets.

In case the State Department of Public Works decides to locate the railway terminal of the Transbay Bridge along the Embarcadero at or near the Ferry Building, then the Market Street Subway would have to be extended east instead of turning south under Fremont Street. Records show that the shore line of the Bay was originally at First and Market Streets so that all of the extension would be in water bearing ground which has been artificially made. Due to this and to unfavorable foundation conditions, the building of this subway extension would be very costly. That this would be so was demonstrated by the difficulties encountered in the construction of the Embarcadero Underpass in front of the Ferry Building, which not only cost a large sum of money, but consumed a great deal of time in its construction.

We have considered the possibilities of operating the subway cars on the surface east of First Street. To do this would require a ramp from the subway to the surface with grades to suit surface car operation in the downtown section. Doing so would place an open well approximately 350 feet long and about 30 feet wide in the center of Market Street, reducing the traffic capacity of the street and presenting a barrier to all cross traffic at this location. Train operation, in the future, would not be practicable via this ramp, so that a costly extension of the Market Street subway is the proper means of providing rapid transit at the railway terminal of the Transbay Bridge, if it be located on the Embarcadero.

Market Street between Fremont Street and the Embarcadero will continue to be served by surface cars as at present, after the subways have been built.

At the westerly end of the Market Street Subway near Church Street the tracks will be brought to the surface by a ramp. By stopping the subway at this point, the Church Street "J" Line, the Twin Peaks "K" and "L" Lines and the Sunset "N" Line can be connected with the subway by rearranging the surface car tracks. Extending the proposed Market Street Route to provide a subway connection to the Twin Peaks

Tunnel would reduce the travel time for the patrons of the "K" and "L" Lines by less than one minute, and this would require that provision be made to take the "J" and "N" Lines into the subway via other ramps. The cost of building such a connection is about \$3,000,000 which expenditure is not warranted at the present time by the resulting reduction in travel time. The Church Street ramp should be designed so as to permit extending the subway to connect with the Twin Peaks Tunnel in the future.

The construction of the subway will result in removing the two outer tracks on Market Street between Kearny and Church Streets. The use of the two middle tracks on Market Street between Church and Castro Streets, by both Municipal and Company cars will permit the removal of the two outer tracks along this portion of the street. The change from four to two surface tracks on Market Street west of Church Street will eliminate much of the present interference between automobile and street car traffic at Castro Street.

The removal of the outer pair of surface car tracks on Market Street from Kearny to Castro Streets will provide room for two additional vehicle lanes, thus materially improving traffic conditions on this important thoroughfare.

**Mission Street-Bernal Cut Route**—This two-track subway and surface route connects with the Market Street Subway at Van Ness Avenue, the outbound track being depressed to avoid a grade crossing with the Market Street tracks. This subway will extend under Mission Street to the old right of way of the Southern Pacific Co. near 24th Street. The subway continues under this right of way to the neighborhood of Dolores and 27th Streets, where the tracks reach the surface by a ramp; then they continue on the surface over the old right of way of the Southern Pacific Co. and through the Bernal Cut to a terminal near Monterey Boulevard. For operation beyond the terminal and from some stations along this route the use of buses is recommended to extend the benefits of rapid transit into adjacent territories.

The route extending from 24th Street to Monterey Boulevard over the old right of way of the Southern Pacific is recommended because of its favorable grades and because it costs less than any other line that can be built to serve this territory. It also opens a new residential section for development. If the right of way cannot be acquired at a reasonable cost, alternative routes are available. Mission Street is one of these alternative routes, in spite of its disadvantageous grades and the facts that the rapid transit service would overlap that now being furnished by a surface railway line.

When the traffic on the Mission Street-Bernal Cut Route develops to such proportions that the capacity of the tracks on lower Market Street, to which it connects, is reached, it will be desirable to separate the tracks of this route from the downtown portion of the Market Street Route and extend same through the business district via an additional subway under Mission Street.

**Geary Street-Montgomery Street Route**—The two-track subway under Geary Street extends from Hamilton Square to Market Street, thence easterly under Market Street to Montgomery Street, thence northerly under Montgomery Street to an incline or ramp near Columbus Avenue and Washington Street.

At Hamilton Square a ramp will bring the surface tracks of the Geary Street "B" Line and California Street "C" Line into the subway. If unification is consummated, one or more additional surface car lines may be connected with the rapid transit system via this ramp. At the Columbus Avenue ramp connections are made with the surface tracks on Columbus Avenue over which some of the "F" Line cars may be operated.

Geary Street is recommended for the subway route because the lower part of it is an important business street while the westerly portion is midway between Golden Gate Park and the Presidio Reservation. Montgomery Street is recommended because it passes through the financial district which is the destination of the majority of the inbound passengers passing Third and Market Streets.

A subway station under Market Street between Geary and Montgomery Streets will permit convenient transfer between all routes of the recommended rapid transit system.



## **RAPID TRANSIT SUBWAY STRUCTURES**

The subway structures required for the rapid transit system herein recommended are to be built of structural steel and reinforced concrete according to the latest engineering standards adapted to the conditions encountered in the City of San Francisco.

The experience of other cities with the construction of subways has proven that they can be built without disturbing the normal use of the street for surface traffic or interfere with access to abutting buildings. To accomplish this the existing street pavement is removed and replaced by heavy plank decking, under which all excavating and construction work is carried on. The decking is supported to a plane below the bottom of the subway excavation and it remains in place until the construction work is completed. Water pipes, electric light and power wires, telephone cables and sewers will be supported from the decking structure during excavation, so that these essential services will not be interrupted. The existing underground gas pipes will be temporarily replaced by pipes above the street surface in order to insure maximum safety during construction. Street car tracks, lamp posts, fire alarm boxes, traffic signals and all other surface structures will be supported on the decking at their present locations. Upon completion of the underground work a new pavement will be laid on the street surface.

The stations are to be so located as to insure the most advantageous operation and to serve the convenience of the greatest number of passengers. The stations are to be roomy, well proportioned and pleasing in appearance, with the train platforms of sufficient width so that when multiple unit trains are operated in the subway there will be no crowding on the platforms or other portions of the subway stations.

It is recommended that the downtown stations of the Market Street Route be built with mezzanines above the trackways and platforms. These mezzanines will provide direct access from either side of Market Street and from the intersecting cross streets to both the in and outbound train platforms so that rapid transit passengers will not be delayed by having to cross the street surface traffic. The mezzanines can also be arranged so that they can be used as underpasses by pedestrians, thereby providing an additional means of crossing Market Street, and decreasing interference with surface traffic. In our opinion, the cost of providing the mezzanine type rapid transit stations along lower Market Street is warranted by the existing congestion at the street surface and by the large number of passengers that will use these subway stations.

The piston action of the subway cars will insure an adequate supply of constantly renewed fresh air for the comfort of the subway passengers. Emergency exits leading to the street surface are to be provided between stations so that prompt exit from or access to the subway can be had, should that become necessary. The subway will be waterproofed in accordance with the best known methods, but some water will find its way into it, mostly at stairways and ramps. A drainage system served by automatic pumps will quickly dispose of such water as finds its way into the subway and maintain it in a sanitary condition at all times.

## **SIGNALS AND ELECTRICAL EQUIPMENT**

Block signals should be provided in order that fast transportation service can be had with maximum safety. The electric current for lighting the subway stations and the trackways between stations should be obtained from several sources, so that the failure of one supply will not darken any part of the subway.

## **CARS AND BUSES**

The cars of the Municipal Railway System are roomy, substantially constructed and maintained in excellent condition. These cars have been operating satisfactorily for years through the two-mile long Twin Peaks Tunnel under conditions similar to subway operation. By making certain recommended changes in these cars and their equipment, they will be made suitable for use in the subway. New cars to be purchased should be designed especially for subway transportation use and should be provided as rapidly as conditions permit.

A sufficient number of buses or trolley buses are to be purchased for use as an auxiliary service to the rapid transit lines in residential sections, where the amount of traffic does not yet warrant the cost of providing rail transportation.



## STORAGE AND MAINTENANCE OF CARS AND BUSES

Storage space, with a car barn and repair shop, is to be provided for the maintenance, inspection and repair of the cars and buses of the rapid transit system which cannot readily be accommodated with the present facilities. These facilities will permit the efficient maintenance of all rolling stock in first class condition and insure uninterrupted rapid transit service.

## ACKNOWLEDGMENT

Plans, estimates and data prepared by the Engineers of the Public Utilities Commission and by the City Engineer, have greatly facilitated our work. A great deal of time was saved by the active wholehearted cooperation of Mr. Edward G. Cahill, Manager of Utilities, and by the members of his engineering staff. We are particularly indebted to Mr. Paul J. Ost, Chief Electrical Engineer, and Mr. L. M. Perrin, Electrical Engineer, who gave freely of their time to us and whose intimate knowledge of the San Francisco transportation situation made it possible to complete this report in such a short time. The routes recommended are substantially the same as those which have been suggested by Mr. Ost. The data contained in the report on "Rapid Transit Plans for the City of San Francisco", prepared in 1931 by the late M. M. O'Shaughnessy, then City Engineer, was of value in arriving at the recommendations set forth herein.

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San Francisco, California.  
Dated, July 9, 1935.

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